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Systems and environmental decision making - postgraduate open-learning with the Open University

Chris Blackmore and Dick Morris

1 Introduction

The Open University (OU) is the UK's largest university, with some 200,000 students engaged in supported open learning, usually at a distance. Students use a range of different course materials and media (print, audio-visual, computing, on-line conferencing etc) and are supported by a tutor (Bell, this volume). The OU has been involved in both environmental and systems teaching, mostly at undergraduate level, since shortly after its inception in 1971. The university's provision for postgraduate students has however increased rapidly over the past decade and in 1997 it launched a Masters Programme in Environmental Decision Making which built on some existing courses. This paper is about a Systems course that was developed specifically for the core of that Programme - *Environmental decision making: a systems approach*, also known (affectionately) within the OU by its code, T860. Over 400 students have completed the course since it began. T860 accounts for a quarter of the study time for a Postgraduate Diploma or one sixth of an MSc, in Environmental Decision Making. The course aims to enable and encourage students to approach decisions involving the environment in a systemic manner, by appropriate exploration of the decision context, taking account of a wide range of factors and stakeholders. It is complemented in the Masters Programme by other courses which stress specific aspects of environmental management, such as energy analysis, environmental ethics and health and safety. Students who take T860 usually have a previous degree but in some cases begin it on an 'open entry' route to this postgraduate Programme. The MSc is completed by conducting a dissertation based on a student-chosen project. (See Figure 1).

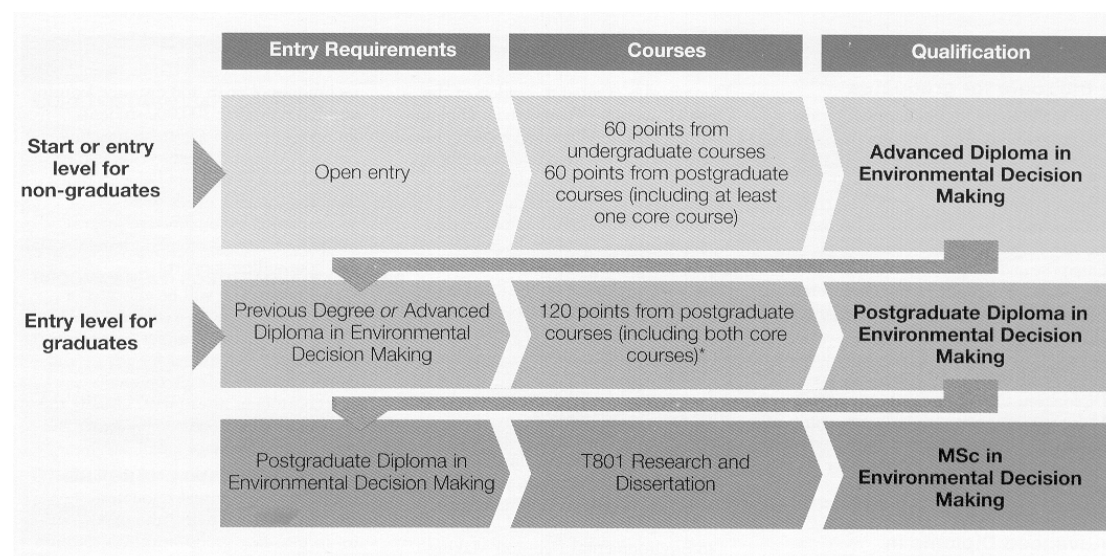


Figure 1 General structure of the Environmental Decision Making MSc

2 Why environmental decision making?

Environmental decision making is, tautologically, decision making that has an effect on our environment. There are however, many different understandings of the word 'environment' (Smyth 1992, 1998). In popular usage, the term is often associated with a qualifier, as the natural, biophysical or ecological environment. Within the systems literature, the environment of a system is understood as that which is outside its boundary or as equivalent to its context (Checkland, 1984, Capra 1996). T860 adopted a broad definition of environment, taking it to mean that which surrounds and affects an individual or a group of living things. The course emphasised the relationship between people and their environment(s) and its many dimensions – physical, biological, social, psychological, technological, emotional, economic – even temporal. This stress recognises the specifically systemic notion of environment, acknowledging that a system is always coupled with its environment and that a system has a purpose and boundaries determined by one or more observers.

Given the breadth of this definition of environment, nearly all decision making could be considered to be environmental decision making. So why is it necessary to talk about environmental decision making at all rather than simply decision making? The T860 course team felt it necessary because there is increasing recognition that many of the decisions we make and actions we take, both individually and in groups, have an effect on our biophysical and social environment (Blowers, 1993; Orr, 1992). Yet without explicit reference to this aspect of environment, economic and political considerations often seem to dominate decision making in a way that excludes other considerations, such as natural/biophysical features. The continued integrity of the biophysical environment is a major tenet of sustainable development (World Commission on Environment and Development, 1987). However, Glasbergen and Corvers (1995) point out that few, if any, economic and political structures now in place are based on this concept and governmental and many international decision-making structures are not designed for dealing with such environmental issues. At a local level, many consumer decisions are made largely on economic grounds. Gandhi in 1947 said that 'The Earth has enough for everyone's need but not for everyone's greed'. 50 years later, Myers (1997a) pointed out, when discussing consumption in relation to population, environment and development, that this statement was made when the world population was 45% and global consumption was 25-30% of today's figures. He states that change will come, whether by design or default, because the Earth is not able to support current consumption trends as exemplified by the fossil-fuel/carbon dioxide connection to global warming. This position has been disputed by the so-called contrarians (Avery, 1995) and, in 2001 appeared to have been dismissed as an element in the economic policies of the USA.

However, Myers talks not just of the problems associated with change but of opportunities to relieve consumption pressures through enhanced technology or shifts in lifestyle. This suggested way forward brings in a wide range of considerations. The main challenge seems to be not one of replacing economic, political, technological and social considerations with an ecological/environmental agenda but in recognising that they are all systemically inter-related and bringing them together

in decision making. Our focus on environment is not to separate it out but to ensure it does not get forgotten.

3 The T860 systems approach and conceptual framework

The academics in the T860 course team (Appendix 1) come from a range of different backgrounds in relation to environmental decision making and most of them are from the OU's Systems Discipline. There was a long history of concern with issues related to the living world in the courses produced by the Discipline. The development of many ideas in ecology parallels changes in the nature of systems thinking and the treatment of ecological systems in the Open University's courses has changed with this. In the earliest course, the focus was on the management of ecological systems for closely defined objectives (T241, 1973). In the revised version of this course, the stress moved to the linkages between ecological and social systems, where the management objectives were multidimensional. More recently, the very notion of achieving agreement over managing ecological systems for human ends has been seen to be problematical (Ison & Russell, 1999). In T860, the starting point was to acknowledge the systemic nature of the issues the course was trying to address, and the course was based around a framework designed to encourage a systems approach by students (Figure 2). The components of the framework are also related to the titles of the six blocks of text for the course, given in Table 1. Further details of the course's aims, learning outcomes and approach can be found in Appendix 2 and elsewhere (Blackmore *et al* 1998).

Table 1. Course texts

Block	Title
1	Introduction to Environmental Decision Making
2	Exploring the context of Environmental Issues and Formulating Problems and Opportunities
3	Models for Environmental Decision Making: Descriptive Models
4	Models and Decisions
5	Evaluation, Monitoring and Taking Action
6	Testing the Environmental Decision Making Framework

The conceptual and methodological framework around which the course is structured is shown in Figure 2.

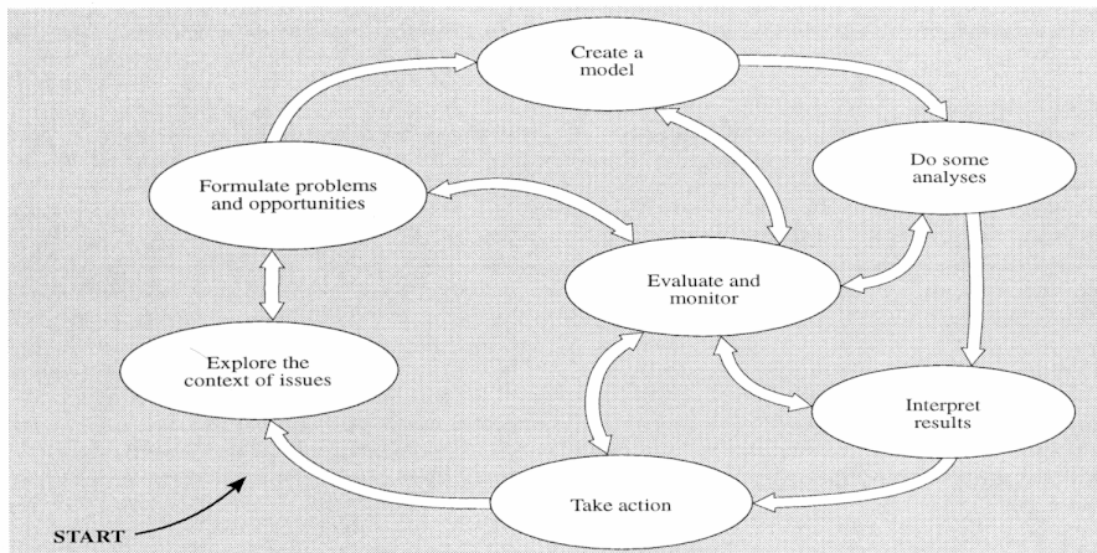


Figure 2 The T860 environmental decision-making framework
(Source: Open University T860, 1997)

The framework is intended to enable stakeholders to take a systems approach to environmental decision making in many different situations, in the community, at work and at home. Its major features are its strongly iterative nature, stressing exploration of the context of environmental issues and the importance of modelling, evaluation and monitoring before and after taking action. Local, national and international environmental decisions are considered including some of those involved in waste management, transport planning, environmental impact assessment and developing environmental management systems. The framework is reflected in the block structure shown in Table 1. Block 1 comprises an introduction and case study. Blocks 2 to 4 work through the various stages of the framework and Block 6 uses a case study to complete a second iteration of the framework. Students then go on to use the framework in their own environmental decision-making situations in their projects. Any decision is expected to lead to some action, and this is examined using students' own actions relating to their environmental decisions and through their projects.

T860 introduces and uses a range of systems concepts, including boundaries, open and closed systems, feedback and emergent properties (Wilson, 1984, Pearson and Ison, 1992). Some basic techniques such as systems maps and multiple-cause diagrams are used for representing the systems of interest which can be identified in a situation. It also stresses the importance of distinguishing between "messy" and "difficult" problems and of taking into account the variety of perspectives likely to be held by different stakeholders.

The course advocates using *both* systemic and systematic thinking and action and *both* 'soft' and 'hard' approaches for environmental decision making, rather than just one or the other. Systemic thinking in environmental decision making provides the context for systematic thinking and action, with the latter possibly using some of the more formal techniques included in the course. These include standards for Environmental Management Systems (such as the Eco-Management and Audit

System, and the ISO14000 series) and Environmental Impact Assessment. T860 does not go into these techniques in great detail (that is done in other courses in the Masters Programme) but concentrates on how they are used. It argues that it is possible to use them either very literally and systematically or both systemically and systematically. Very different outcomes may be achieved in environmental decision making, depending on how these techniques are interpreted and used.

An essential part of these formal techniques and of the whole decision making framework is modelling. A range of pictorial, diagrammatic and mathematical modelling techniques are introduced, broadly divided into those used descriptively and those used prescriptively. Students were initially provided with three computer-based examples of mathematical models - a spreadsheet model of the economics of landfill, written in Excel 5™, a highly simplified equation structured model of a wetland using Modelmaker™ to examine the effects of water extraction and a Life-Cycle Analysis package (SimaPro™). These models were used to explore the possible consequences of particular decisions, and to provide students with a critical appraisal of the modelling process.

Prescriptive models analysed in the text include linear programming, multi-criteria models, expert systems and economic models of preference. The assumptions and limitations of these techniques for "rational" decision making are examined using a series of small case studies. Students are encouraged to examine the nature of the systems represented by the models and their relationship to different stakeholder perspectives.

Evaluation, monitoring and auditing are essential activities in environmental decision making. A systemic approach to evaluation is introduced, which includes systematic aspects. It distinguishes between systems which have external measures of performance imposed on them (*purposive systems*) and those which are formulated and reformulated with their own measures of performance (*purposeful systems*). Evaluation strategies that are audit-based and learning-based are most likely to lead to purposive and purposeful evaluation systems respectively. The practice of evaluation, monitoring and auditing is examined by reviewing the formal and non-formal techniques for environmental decision making discussed in the course. T860 assumes the need for a participatory approach to environmental decisions (Pretty, 1994) to gain multiple perspectives on systems of interest. It introduces techniques for identifying different stakeholders and involving them in the decision-making process.

While advocating participation in some circumstances, the course does take a critical approach and encourages students to do likewise. There were differences in worldviews and writing styles among the course team as is evident from the content of different blocks of the course. However, the team felt that this was a strength rather than a weakness in a course where students were being encouraged to develop awareness of different perspectives, including their own. The course encourages students to be aware of the author's perspectives and draws out value judgements of the authors as teaching points wherever possible. For instance one of the 'self-assessment questions' asked by the author of case study in Block 1 is 'Do you think my comments on the public inquiry process are impartial?' Another example is given in Block 5. When students are asked 'What is it that drives you to do what you do? Try to ground your answer in a specific example of your behaviour. What conclusions do you draw from your answer in terms of taking action in environmental decision making?' two different example answers are given by the two block authors.

4 The use of case studies

The two major case studies in Blocks 1 and 6 of the course use the whole framework and a number of smaller case studies illustrate particular details. The first case study introduces the whole topic of environmental decision making and later blocks of the course use it as a general context for other stages of the framework and to illustrate aspects of stakeholding, conflict and decision-making methods. The study concerns the choice of route for the M3 London to Southampton Motorway around Winchester. The history of the situation was compiled from literature sources and interviews with a number of stakeholders; the text description is backed up with a video which includes location scenes and interviews with participants in the original situation. The decision to route the motorway in a cutting through Twyford Down, a Site of Special Scientific Interest, was notable for the level of controversy it generated, and for a number of decisions which appeared difficult to justify, at least to a substantial proportion of the stakeholders. It serves a number of purposes in the course, alerting students to various aspects of environmental decision making, and offering a vehicle for a first, *post hoc* use of the framework as a marker against which to examine the decision making processes which appeared to have operated in this situation. Major lessons students were expected to learn are:

1. The lack of any clearly systemic process in the situation
2. A probable failure to address the concerns of many of the stakeholders
3. The possible existence of hidden agendas among the more powerful stakeholders
4. Disparity of power between different stakeholder groups.

The case studies used to illustrate particular concepts or techniques at appropriate points in the teaching text are much shorter than the Twyford Down study and most rely on published literature sources, mainly from within the last decade. For example, a particularly useful pair of studies concerns waste management in Taiwan, used to illustrate the use of programming to optimise the location of waste management facilities. Two separate published accounts were taken. The first is a technical description of the modelling study (Chang and Wang 1996). Students are required to identify the way in which the model was constructed, and to check that the relationships postulated were plausible. The second (Shen and Yu, 1997) described the history of waste management in Taiwan, and suggested that, while the modelling activity described in the preceding paper was a completely rational approach to the problem, the social and political realities of the country were such that the proposed optimal solution was most unlikely to gain public acceptance.

The second major case study, on Genetically Modified Organisms, demonstrates the use of the framework as a basis for analysing a situation where no clear end-point has been reached. The aim is to reinforce the teaching of earlier blocks, by going through the stages of the framework once again and testing their application to a very different decision. Decisions over the release of Genetically Modified Organisms, are taken at national and international level, with advice from scientific experts, involving considerable uncertainty, and with few opportunities for wider participation. Students are asked to compare the reported decision process against the course's framework, to identify where the current process appeared to accord with, or differ from this. Information is supplied in the form of readings, and a video including interviews with

a number of the actors in the situation. Students are encouraged to use current press coverage of the topic for updating.

This case study was designed to show students how they might use the whole framework in the environmental decision they had chosen for their own project.

5 Assessment

Student progress is assessed using three tutor marked assignments (TMAs) and a student chosen project, which is used instead of an end of course examination. The TMAs are designed to test students' understanding of basic concepts and of modelling, to support the project, and to encourage them to analyse their own skills, knowledge, values and progress. Students' projects count for 50% of the assessment for the course. They are expected to choose an environmental decision-making situation in which they have some stakeholding, to use the course framework as a basis for analysis of the situation and in some cases, as a basis for action. Project assessment is based on defined criteria drawn from the stages of the T860 framework, its use as a whole and its critical analysis. Each project is assessed by the tutor (an OU Associate lecturer) to whom the student is allocated, and independently also by another marker who is usually another T860 tutor. A variety of co-ordination and moderation processes has been used to produce consistency of marking between tutors, and in general, tutors can reach agreement on the mark for any one project. Where no agreement can be reached, the script is marked for a third time by a member of the course team, and this mark is entered in the student's record.

6 Analysis of students response

The numbers of students registered for the course, the final pass rate during the first six presentations are given in Table 2. The pass rate and the average standard achieved in the projects are regarded as highly satisfactory. The external examiners have commented very favourably on the high standard shown in some of the best project reports.

Table 2. Course statistics

Year	Total examined	Mean Project mark	Overall pass rate
1997K	51	55.03	88
1998E	41	52.50	81
1998K	63	59.13	81
1999E	76	55.65	85
1999K	86	59.31	88
2000E	62	59.98	87

An end-of-course survey of the first cohort of students was conducted to determine their response. The project reports were also analysed to determine in more detail how the methodological framework had been used (Morris *et al*, 1999). The overall response was positive, with most students reporting that they felt they had learned useful skills and concepts from the course and as a result, were able to participate more effectively in environmental issues. Students reported that the most useful components of the course were the printed texts and the Tutor Marked Assignments, which were deliberately structured to lead them towards their project work. Students

judged that these became more difficult as the course progressed. Over 70% of students found the project interesting, and a similar proportion also scored it as difficult. The detailed analysis looked at the way that students had used the framework, to identify the extent to which it appeared to have been successful in encouraging a systemic approach to the environmental issues concerned, and to identify any difficulties with use of the framework by relatively naive users. In Table 3, the projects are classified according to the level of situation chosen (Uphoff, 1992) .

Table 3. Level of situations chosen:

<i>Situations</i>	<i>Percentage</i>
Household	1.5
Group	5.4
Community	9.5
Locality	40.5
sub-district	5.4
district	6.8
regional	10.8
national	18.9
international	1.5

Students' interest as stakeholders in issues to do with their locality was perhaps predictable. The numbers looking at regional and national issues is more surprising, as the extent of their stakeholding in these might be expected to be relatively low. Land-use topics, usually planning, were dominant. The issues chosen were also categorised as operational, tactical, strategic or policy, with approximately equal numbers in the last three categories and only 17% classed as operational. Students' roles in the issue were classified broadly into four categories, shown in Table 4, with the numbers involved in each role.

Table 4. Students' roles in their chosen project issue

Role	Percent of all students
1. Formal passive; Student had a formal role reporting on activities mainly involving others,	2.6
2. Formal active: student had a role in the issue not just as reporter..	44.6
3. Self-appointed passive; reporting on activities mainly involving others, with no formal role for student	29.3
4. Self-appointed, active; student was actively involved in the issue, but did not have a formal position	24.0

The high proportion taking a formal active role reflects the number of students who were taking the course for professional or other job-related reasons. The "self-appointed, passive" category was surprisingly large, with this category particularly over-represented in those looking at national issues. This suggests that many of the students were using the framework in a *post hoc*, analytical manner and this pattern has been repeated in succeeding years. The projects were also classified according to their starting and end points, into those which began based on historical material, those which began as an "objective" analysis of an ongoing situation, those where the

student was an active participant in such a situation and those where some proactive, design process was involved. Working with the framework in their projects appeared to move students from *post hoc*, or passive analyses (the upper rows of Table 5) at the beginning of their projects to more active categories of involvement (the lower rows) at the end. Perhaps surprisingly, despite this change in involvement, 69% of students did not accept that working with the framework had challenged their views or attitudes. More than two thirds of all students appeared to find the initial stages of the framework (exploration/formulation/modelling) difficult, but these stages were also rated above average for helpfulness.

Table 5. Change in student role in project situation

	Percentage at start of project	Percentage at end of project process
<i>Post hoc</i> (analysis of historic material only)	41.3	17.3
Current, passive (ongoing, but student as observer)	28.0	24.0
Current, active (ongoing, student as participant)	28.0	28
Design, passive (proactive, but student as observer)	2.6	2.6
Design, active (proactive, student as participant)	0	21.3

A major concern of the course was to encourage students to identify and ideally involve, a wide range of stakeholders in their activity. Only 44% of the first cohort progressed beyond identifying the basic or obvious stakeholders. Some students who had a formal, job related role, appeared to be trying to legitimise conclusions appropriate to their formal positions. However, two-thirds of students claimed that the use of the framework had either encouraged them to widen the boundaries of their analysis, or had enhanced their understanding.

Students used the framework in different ways. A substantial minority have always used it in a stepwise manner, "according to the book". The remainder have been more creative, working iteratively through more than once, or adapting the framework to particular needs or situations. A minority have been able to relate to the framework in an epistemologically sophisticated manner, evaluating its strengths and weaknesses in relation both to the way that they themselves have used it and in relation to other methodologies. Students are encouraged to undertake such an epistemological evaluation in their project reports, and marks are awarded accordingly, but this remains an area where many students lose marks. A typical comment from a tutor on a student's project report noted:-

"The student fell into the trap of considering the framework as a prescriptive model or a method [...] as opposed to a framework [...]. As a result, the project is not what it should have been. The student attempted to fit the situation to the framework, rather than compare the situation to the framework."

In general, the students' own assessment of the effectiveness of the way they had used the framework correlated with those of the tutor who reviewed these, suggesting that significant learning had occurred

7 Conclusion

T860 represents a unique synthesis of systems ideas with experience in the rapidly developing field of environmental decision making, where the need for systemic methods is widely recognised but as a general rule, not practised. The literature associated with environmental decision making appears still to be strongly based in a positivist paradigm, with extensive use of very sophisticated modelling techniques, possibly in an inappropriate manner, as suggested by the case studies mentioned earlier. The increasing availability of software, computing power and possibly funding has encouraged this path and in those cases where there is agreement over management objectives, it can be useful. However, the importance of differences of perception of features of the environment has also begun to be recognised (for example, Carr and Tait, 1991, Oreszczyn and Lane 2000). Such differences reduce the appropriateness of more tightly structured modelling approaches, and require that more participatory, learning based approaches are used (Bawden 1995, Uphoff, 1996; McCulloch, 1996, Ison et al 2000). T860 represents the first OU example of an attempt to use distance learning methods to provide skills needed for such a learning based approach in an environmental context, in contrast to the more rigid modelling or procedural approaches that currently prevail. Many of the students who have completed T860 report that it has had a lasting effect on how they approach environmental decision making.

A typical comment from a student is:

“Perhaps where I gained most was in Block 2, i.e. in exploring problems and opportunities, stakeholder analysis and diagramming to clarify thinking. There was a lot of emphasis on ‘participatory and joint learning’ approaches and it was a challenge to try to think of ways to introduce this line of thinking into a systematic inquiry process.”

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Appendix 1

T860 Course Team

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Andy Lane, Critical Reader
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Laurence Newman, Publicity
Pam Owen, Graphic Artist
Jo Rogers, Project Control
Jane Sheppard, Graphic Designer
Amanda Smith, Editor
Marjorie Thompson, Course Secretary
Bill Young, BBC Producer

Appendix 2

T860 Aims and learning outcomes

Aims and learning outcomes were planned for the whole course and at a more detailed level for each block. The aims applied to what the course team was intending to do and the learning outcomes were those intended for students.

The following are for the course as a whole:

Aims

- To provide an understanding of environmental decision making
- To introduce a range of ideas and techniques that have the potential to support environmental decision making
- To show that there are many different perspectives on environmental issues
- To give examples of how multiple perspectives can be taken into account in decision making to bring environmental and development agenda together
- To consider how modelling is used in environmental decision making
- To provide a useful but non-prescriptive framework for environmental decision making

Learning outcomes

After completing this course students should be able to:

- understand how your own and other people's perspectives and motivations affect environmental decision making
- recognise the major factors that influence decision making
- identify the stakeholders in an environmental issue
- use diagrammatic models to analyse and support environmental decision making
- analyse critically the use of mathematical and computer-based models as part of the process of environmental decision making
- develop monitoring and evaluation processes for environmental decision making in relation to different forms of environmental action
- make choices between different course of action to address environmental issues

Appendix 3

T860 Course components

- (i) **Six ‘blocks’ of written material**, listed in Table 1
- (ii) **Other written materials** including a course guide, a project guide, audio-visual notes and assignments.
- (iii) **Video and audio material.** Three videos were produced for the course. The first video ‘Why Twyford Down?’ supports the Block 1 case study. The second video ‘Participating in environmental decision making’ supports Block 2 and focuses on participatory techniques for environmental decision making and some of the issues of facilitating environmental decision-making processes. The third video ‘Biotechnology - whose science, whose ethics?’ supports the Block 6 case study. An audiotape is also used to talk through the whole-course framework and use of the computer-based models used in Block 3.
- (iv) **Computer modelling software**
Three computer-based models are introduced. Demonstration software was provided for two of them and the third is a waste management spreadsheet model where students require Microsoft Excel software to be able to run it.
- (v) **‘FirstClass™’ software** for use of Open University computer conferencing and email facilities. Computer mediated interaction with tutors and other students through computer conferencing and email is an important part of the learning experience for T860. Students are also recommended to make use of the Internet to gain access to a range of different perspectives on environmental decision making. They are responsible for taking out their own subscription to an Internet services provider.